QAPP of the Shipboard Test

OceanDoctor BWMS

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CONTENT

1 Test Objectives

According to the IMO BWM Convention and the Guidelines (G8), and the Guidelines for type approval of Ballast Water Management System published by China Classification Society, Ballast water management system intended to be fitted on board ship should be type approved.

To this end, shipboard test to the OceanDoctor BWMS is to be conducted by Jiujiang Precision Measuring Technology Research Institute, in accordance with the IMO Convention and Guidelines for type approval of Ballast Water Management System to verify the performance of the system and the treatment efficiency. Ensure that the operation of ballast water management systems should not impair the health and safety of the ship or personnel, nor should it present any unacceptable harm to the environment or to public health. And meanwhile to assess whether ballast water management systems meet the standard as set out in regulation D-2 of the “International Convention for the Control and Management of Ships’ Ballast Water and Sediments”.

After the completion of the shipboard test, the shipboard test reports, the land based test reports and the environmental test report will be submitted to Society for type approval.

2 Reference Standards

⑴International Convention for the Control and Management of Ships' Ballast Water and Sediments 2004

⑵ Guidelines for Approval of Ballast Water Management System (G8)

⑶ Procedure for Approval of Ballast Water Management System that Make Use of Active Substances（G9）

⑷Guidelines for Ballast Water Sampling （G2）

⑸Guidelines for Type Approval of Ballast Water Management System（CCS）

⑹Steel Vessel Rules published by CCS

3 Test Equipment

3.1 base unit

Model HBS-250 OceanDoctor BWMS

Treatment rated capacity（TRC）; 250m^3/h

3.2 scaled unit

Model HBS-500 OceanDoctor BWMS

Treatment rated capacity（TRC）; 500m^3/h

3.3 system description

OceanDoctor BWMS is mainly composed of a filtration unit, a photo-catalytic reaction unit, a control unit and the sampling facility.

In order to reduce space occupation, all units can be installed independently. They can either be installed on a common skid which is fit for new building ships or installed separately in conformity with the real installation space of the ships which is fit for existing ships. The general arrangement drawing of the system is as shown in figure 3.1:

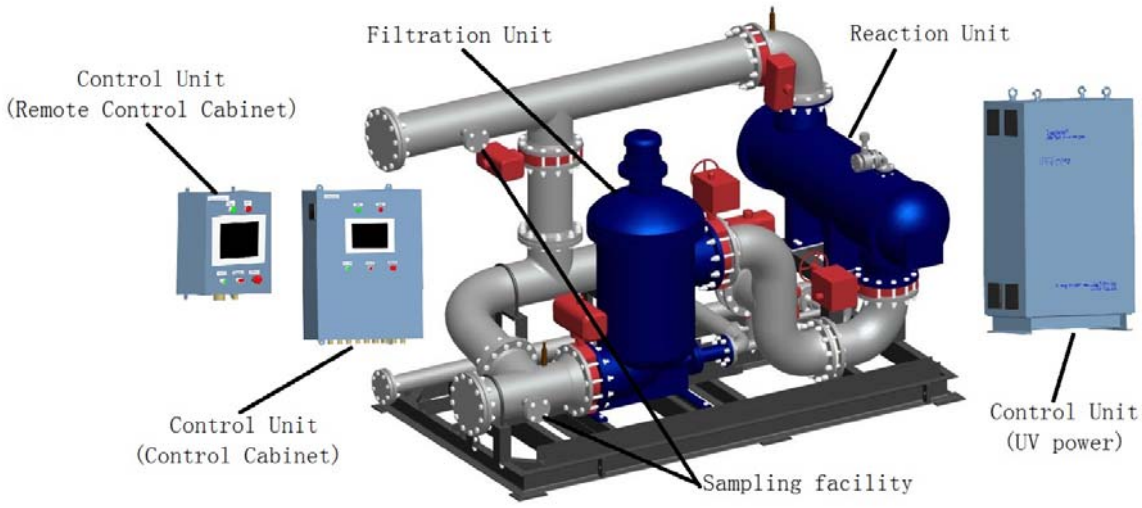


Figure 3.1 general arrangement drawing of the system

4 Test Introduction

4.1 Evaluation before test

To verify that the installation of the ballast water management is in compliance with the installation specifications. The installation process is in accordance with the rules of China Classification Society. The operational inlets and outlets are located in the positions indicated on the drawing of the pumping and piping arrangements.

Commissioning test will be conducted after the ballast water management system is fitted on the ship, the commissioning test includes test to the control and monitor equipment, the safety alarming test and the running test.

4.2 Shipboard test

The test cycles of the shipboard test of the BWMS for type approval including invalid and unsuccessful test cycles are to span a trial period of not less than six months. And three consecutive test cycles are required to be performed that comply with regulation D-2 and which are valid in accordance with the requirement as set out in regulation D-2 of the Convention. A complete shipboard test cycle includes the uptake of ballast water of the ship, the storage of ballast water on the ship, treatment of the ballast water by the BWMS, except in control tanks; and the discharge of ballast water from the ship. And samples are to be taken over the test cycle, and assess whether the treated ballast meet the standard of regulation D-2.

The source water for test cycles shall be characterized by measurement of salinity (PSU), temperature (T), particulate organic carbon (POC) and total suspended solids (TSS).

4.2.1 test particulars

⑴biological efficacy test items;

① Numeration of organisms of greater than or equal to 50 micrometres or more in minimum dimension;

②numeration of organisms greater than or equal to 10 micrometres and less than 50 micrometres in minimum dimension;

③ counting of Vibrio cholerae

④ counting of coliform

⑤ counting of enterococcus group

⑵water quality

①salinity

②temperature

③ particulate organic carbon（POC）

④ total suspended solids（TSS）

4.2.2 Test criteria

The biological efficacy testing of the ballast water management system is assessed during the shipboard test according to the G8.the concentration of organisms and bacteria in the discharge water should meet the standard as set out in regulation D-2.

⑴ less than 10 viable organisms per cubic metre greater than or equal to 50 micrometers in minimum dimension;

⑵ less than 10 viable organisms per millilitre less than 50 micrometres in minimum dimension and greater than or equal to 10 micrometres in minimum dimension; and

⑶ less than the following concentrations of indicator microbes, as a human health standard:

① Toxicogenic Vibrio cholerae (serotypes O1 and O139) with less than 1 Colony Forming Unit (cfu) per 100 millilitres or less than 1 cfu per 1 gramme (wet weight) of zooplankton samples;

②Escherichia coli less than 250 cfu per 100 millilitres; and

③Intestinal Enterococci less than 100 cfu per 100 millilitres.

4.2.3 Evaluation of the shipboard test

（1）The test cycles including invalid and unsuccessful test cycles

conducted to the base unit which is the model HBS-250 OceanDoctor BWMS are to span a trial period of not less than six months, and test cycles conducted to the scaled unit which is the model HBS-500 OceanDoctor BWMS are to span a trial period of not less than three months. Three consecutive valid test cycles that comply with regulation D-2 are required. Any invalid test cycle does not affect the consecutive sequence.

（2）The source water for test cycles shall be characterized by measurement of salinity, temperature, particulate organic carbon and total suspended solids.

（3）The amount of ballast water tested in the test cycle on board should be consistent with the normal ballast operations of the ship and the BWMS should be operated at the treatment rated capacity for which it is intended to be approved.

（4）Documentation that the BWMS is of a capacity within the range of the treatment rated capacity for which it is intended.

（5）Valid tests are indicated by uptake water, for both the control tank and ballast water to be treated, with viable organism concentration exceeding 10 times the maximum permitted values in regulation D-2.1 and control tank viable organism concentration exceeding the values of regulation D-2.1 on discharge.

（6）Success test criteria: three consecutive, valid test cycles showing discharge of treated ballast water in compliance with regulation D-2.

5 Test Organization

The Ballast Water Detecting Lab of Shanghai Ocean University is entrusted to conduct the sampling and analyzing work. And it will assess the biological efficacy of the ballast water management system based on the test results.

The Ballast Water Detecting Lab of Shanghai Ocean University was founded in September 2008. It has been accredited with the 17025 test lab qualification issued by CNAS. There are eighteen people in the lab, among which four people are engineers and scientists with high professional title. The lab consists of sample acceptance room, hydrochemistry room, micro organism testing room, microscope room，balance room and sample storage room. The lab is dedicated to the study of the harbor ecology and Invasion ecology, mainly of the ecology research study of the plankton in harbor area and ship ballast water and the micro organisms in ocean environment. This organization has published over 100 papers in both national and international academic journals. In addition, the lab has obtained four patents authorizations.

The lab is equipped with all kinds of instruments and apparatus, such as BOD_5 analyzer, TOC analyzer, spectrophotometer, stereoscopic microscope, conductivity gauge, turbidimeter for water micro-organism test, environmental parameters detection and plankton test. The related staff is asked to be trained before he or she conducts the testing task. The six doctors and twelve masters are all specialized in the parameter field. By now, the lab is able to test five organism indicators and ten water quality parameters in accordance with the ballast water discharging standards regulated in the International Convention for the Control and Management of the Ships' Ballast Water and Sediments:(1) viable organisms greater than or equal to 50μm in minimum dimension; (2)viable organisms less than 50μm and greater than 10μm in minimum dimension; (3) toxicogenic *Vibrio cholerae*(serotypes O1 and O139);

(4)*Escherichia coli*; (5)*Intestinal Enterococci* ;(6) heterotrophic bacteria;(7)total residual oxidants (TRO); (8) dissolved oxygen(DO); (9) total suspended solids(TSS) ;(10) turbidity (NTU); (11) dissolved organic carbon (DOC) ; (12) particulate organic carbon (POC) ; (13) pH; (14) salinity; (15) water temperature.

Being realistic and creative, the staff of the lab aims to build a competent and famous lab which is specialized in the testing of ships' ballast water in China.

6 Test Method

6.1 test ship

6.1.1information on the test ship

Test ship; ShunAn No.328 dry cargo ship

Class society: China Classification Society

Ship owner: Anqing Shunan shipping Co., Ltd.

Capacity of the ballast pump: 1000m^3/h

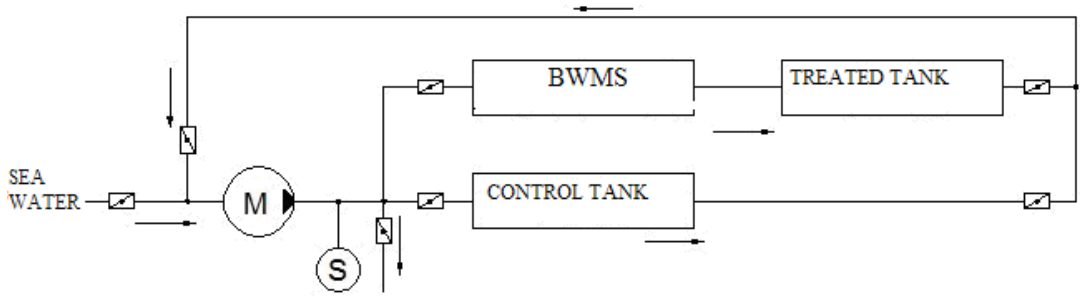
Ballast tanks: 300m^3*2, 600m^3*2

6.1.2 Test navigation route

The navigation route of the test ship mainly covers the national coastal line and along the Yangtse River. Over the whole test period, the test ship will navigate along the ports like Zhoushan, Lianyungang, Qingdao, Dalian. The test water involved includes China East sea, China Huanghai sea and China Bohai sea, the uptake and discharge operation are conducted at the ports or sea nearby.

6.2 test set-up

The test set up is mainly composed of the ballast pump, the OceanDoctor BWMS, the treated tank, the control tank and the sampling facility. The tested equipment (OceanDoctor BWMS) is connected to the ship's piping system by valves and pipes.



M; ballast pump；S; sampling facility；

Figure 5.1 diagrammatical drawing of the test set-up

The test set-up is representative of the real ballasting and deballasting

process. The ballast water is pumped by the ballast pump and flows through the ballast water management system and then enters the ballast tank. The untreated ballast water will enter the control tank by the bypass pipe. When discharging, the ballast water in both the treated tank and the control tank is discharged to the overboard directly.

Information on the two models of the tested equipment:

Model	Ballast pump	Treated tank	Control tank
HBS-250	1000m^3/h	300m^3	300m^3
HBS-500	1000m^3/h	600m^3	600m^3

To ensure that the OceanDoctor BWMS is of a capacity within the range of the treatment rated capacity for which it is intended, the capacity of the ballast pump in the test set-up is 1000 m3/h which is higher than the treatment capacity of the tested equipment. When the test is conducted, the flow of seawater is splited at the outlet of the ballast pump, with one flow to the test set-up by pipe, and the other be discharged over board by the branch pipe.

During test, the capacity of the ballast water to be uptaken or discharged would with reference to the navigation route, the weather and the sea conditions.

6.2.1 sampling facility

The sampling facility named S is installed on the ballast pipe to collect the uptake water sample, the control water sample, the discharge sample from the treated tank and the discharge sample from the control tank. The design of the sampling point is in accordance with requirement in G2; the structure of the sampling facility is shown in figure 5.2:

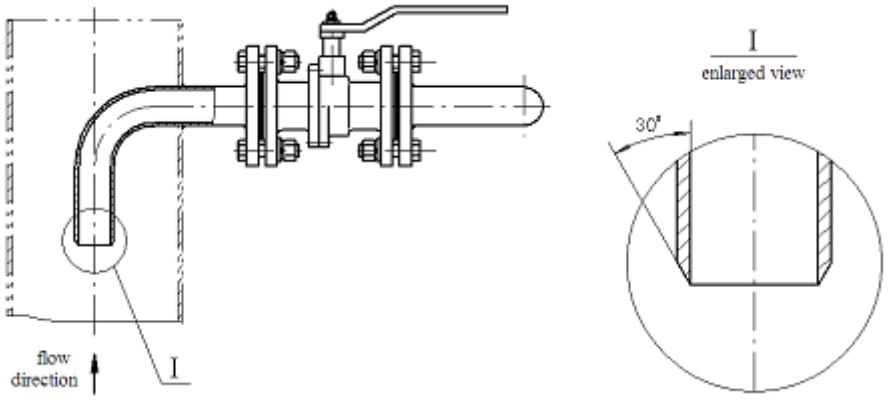


Figure 5.2 sampling facility

6.3 Test Cycles

After the test equipment is fitted onboard, the control and monitoring equipment of the test equipment will automatically record the operation information; all the important parameters like the time of ballasting or deballasting, the flow rate and the total capacity of ballast water will be recorded and stored.

After the ballast water management system is fitted on the ship, for the first use, the system will record the operation information. The time of the first use is considered as the start time of the test. Over the whole test process, the system will automatically record the time and the other parameters in each operation. The test cycles conducted to the base unit are to span a trial period of not less than six months, and test cycles conducted to the scaled unit are to span a trial period of not less than three months. Three consecutive valid test cycles that comply with regulation D-2 are required to the base unit and the scaled unit. A complete test cycle include the ballasting, the storage and the discharge of the ballast water.

6.3.1 Ballasting and treatment

When the uptake operation is to be initiated, activate the ballast pump and the ballast water management system. Then the ballast water is pumped to the ballast water management system, after treated, the ballast water flows to the ballast tank. Moreover, seawater untreated by the ballast water management

system will be pumped to the control tank as well.

6.3.2 storage

The treated ballast water is stored in the ballast tank before discharge and the untreated ballast water is stored in the control tank before discharge.

6.3.3 discharge

The treated ballast water will be discharged overboard by ballast pump; the untreated ballast water will be discharge overboard by ballast pump.

6.4 sampling

In a whole test cycle, the influent water samples are taken during ballast water uptake. The discharge samples from both the treated tank and the control tank are taken when discharging. The sampling is performed by qualify personnel. The arrangement of the sampling point is shown in figure 5.3:

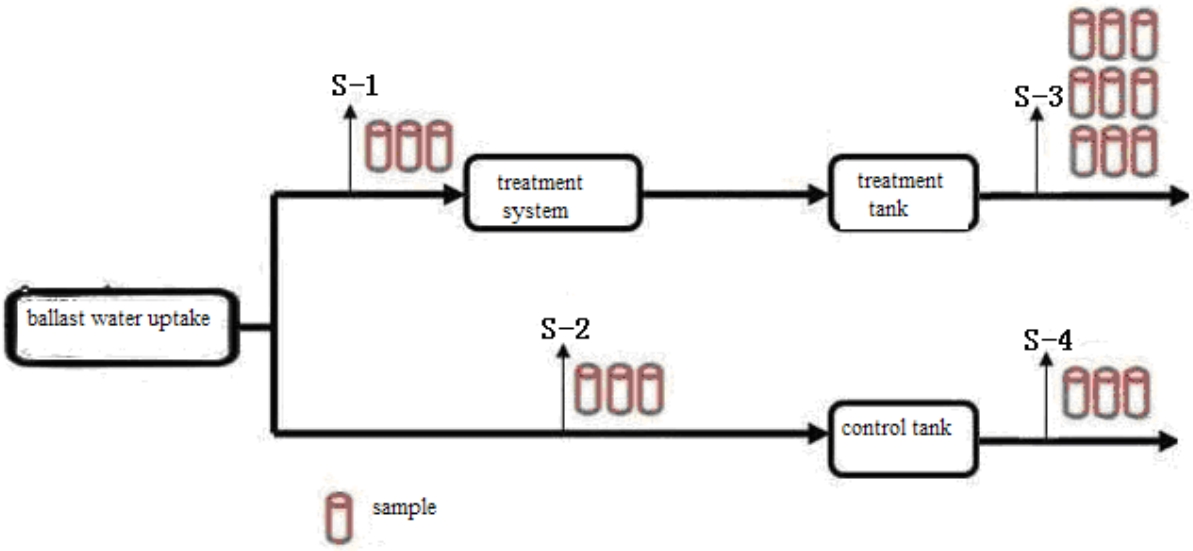


Figure 5.3 arrangement of the sampling points

S-1: influent;

S-2: control water;

S-3: discharge from the treated tank;

S-4: discharge from the control tank.

6.4.1 sampling volume

In order to take representative random samples, before sample collection,

rinse the pipe first for 5 to10 minutes and then conduct the sampling.

When uptake water samples and control water samples are to be taken, collect one sample over the period of uptake (at the beginning, middle, end). When discharge treated water is to be taken, three replicate samples of discharge treated water (at the beginning, middle, end) are collected. When the discharge control water sample is to be taken, three replicate samples of discharge control water (at the beginning, middle, end) are collected. One sample is taken at the beginning, middle, end of discharge of the control water.

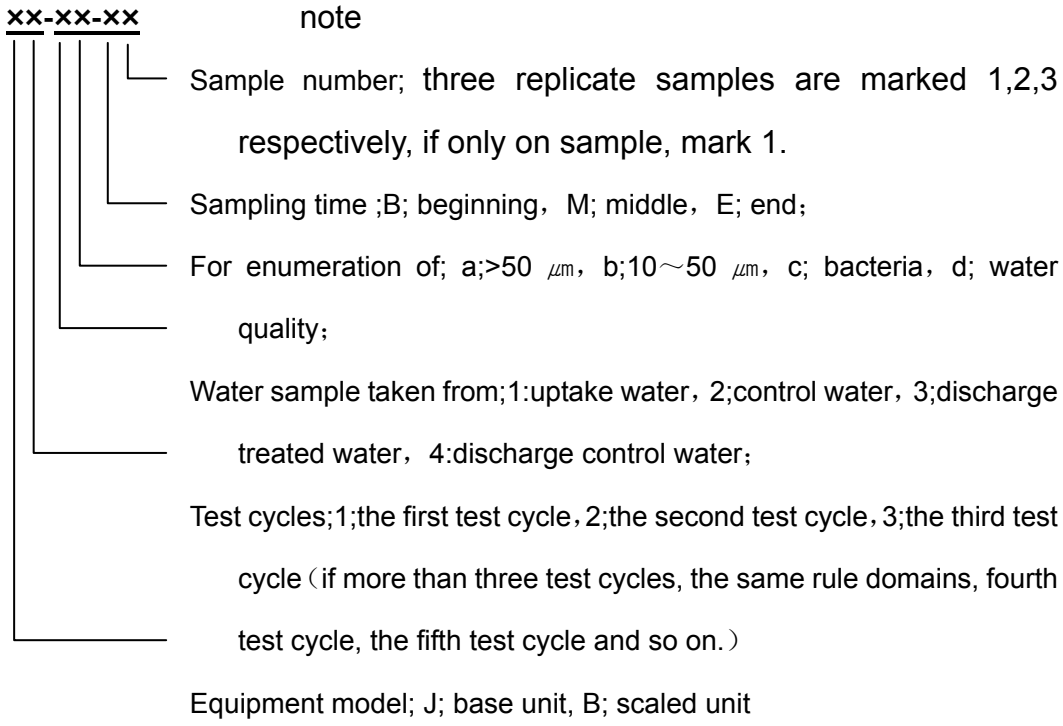
The sample sizes are shown in table 5.1:

Table 5.1 sample volume/size

Water sample		Sampling point	≥50μm	10~50μm	Bacteria	Water quality
influent		S-1	$1m^3$×3	10L×3	1000ml×3	5L×3
Control water		S-2	$1m^3$×3	10L×3	1000ml×3	5L×3
Treated tank discharge	beginning	S-3	$1m^3$×3	10L×3	1000ml×3	5L×3
	middle	S-3	$1m^3$×3	10L×3	1000ml×3	5L×3
	end	S-3	$1m^3$×3	10L×3	1000ml×3	5L×3
Control tank discharge		S-4	$1m^3$×3	10L×3	1000ml×3	5L×3

6.4.2 sample ID code

The numbering rule of the sample is as below:



6.4.3 sample testing

When finishing sampling, the test personnel will pretreat water samples, or add some fixation and store the samples in the refrigerator. Some tests are conducted on board in situ, and others are stored in refrigerator and delivered to the lab for test. For detail, please refer to the QAPP documented by the test organization.

6.5 preventing cross-contamination between cycles

To ensure the independence of every test cycle and avoid the cross-contamination between periods and cycles, the test pipe is to be washed for 5 to 10 minutes before sampling. At the completion of each period in one test cycle, the pipes and the sampling facility are to be washed. After the completion of each test cycle, the BWMS, the ballast tank and the control tank are to be washed.

6．6 test record and sample data record

Information on each test cycle over the shipboard test will be recorded, mainly from three aspects:

（1）sampling information, refer to the sample data record in table 6.1;

（2）documentation of functioning of the control and monitoring equipment in each test cycle; recorded in table 6.2

In addition, information such as: all ballast water operations including volumes and locations of uptake and discharge, and if heavy weather was encountered and where, is recorded.

6.7 maintenance and repair

After the OceanDoctor BWMS is installed on the ship, the shipboard test will be started when the system is commissioned to the normal working status.

In the process of the shipboard test, a periodic (once two months) test and maintenance will be carried out for sake of a better understanding of the system operation and the working status of all components. The testing and maintenance to be performed includes:

（1）check if the system operation and control is normal ,including the functioning of the control program, the touch screen, and the buttons;

（2）if the sampling facility work well, its flow rate is within the specified range.

（3）the main components of the system is in normal operation, such as the UV lamp, the ballasts, the UV sensor, the liquid level switch, the flow meter and the temperature sensor.

（4）check if the system could keep a normal record of the operation record.

Routine maintenance and trouble-shooting procedures should all be covered in the test record.

Over the shipboard test, except for the scheduled maintenance,

maintenance performed to any abnormal or component default occurred to the system is required to fill the test operation record, refer to table 6.3.

Table 6.1 Sample data form

NO.：

Items	Description	Description	Description	Description
Sampling date				
Name of ship				
Distinctive number or letters				
Port of registry				
Gross tonnage				
Date of construction				
Ballast water capacity				
Origin of water sampled(port, harbor)				
Type and position of the sampled tank				
Capacity of the sampled tank				
Type of ballast water management undertaken				
Make of ballast water management system				
sample ID code				
Sample type（larger，small plankton, microbes）	10～50μm	≥50μm	bacteria	Water quality
Sampling techniques used				
Net (including depth of vertical net haul, net opening size, mesh size)				
Pump（sampling depth, pump flow rate 1/min）				

Bottle (sampling depth, bottle capacity)				
Specify other sampling technique if used				
Sampling start time				
Sampling end time				
Type of sampling access point（uptake/ discharge）				
Location of sampling access point（uptake/ discharge）				
Water volume sampled				
Size of the sieve for concentration of sample (μm)				
preservative（if used）				

Recorder：　　Sampler：　　Quality manager：

Project manager：　　Supervisor：

Table 6.2 System operation record sheet of BWMS

<table>
<tr><td>试验单位
Entrustment organization</td><td colspan="4">九江精密测试技术研究所
Jiujiang Precision Measuring Technology Research Institute</td></tr>
<tr><td>试验设备
Test equipment</td><td colspan="4">☐ HBS-250 型海博士压载水管理系统/HBS-250 OceanDoctor BWMS
☐ HBS-500 型海博士压载水管理系统/HBS-500 OceanDoctor BWMS</td></tr>
<tr><td>额定处理能力
Treatment Rated Capacity</td><td colspan="4">☐ 250m^3/h ☐ 500m^3/h</td></tr>
<tr><td>循 环 数
Test cycles</td><td></td><td>试验开始/结束时间
Start time/End time</td><td colspan="2">From to</td></tr>
<tr><td>压载地点
Uptake Location</td><td></td><td>排放地点
Discharge location</td><td colspan="2"></td></tr>
<tr><td>舱 容
Capacity of the sampled tank</td><td>☐ 300m^3
☐ 600m^3</td><td>压载水量
Ballast volume</td><td colspan="2"></td></tr>
<tr><td>是否遭遇恶劣天气
If Heavy weather was encountered</td><td></td><td>遭遇恶劣天气的地点
Where did the heavy weather be encountered</td><td colspan="2"></td></tr>
<tr><td>Supervision unit</td><td>中国船级社武汉分社
CCS Wuhan Branch</td><td>见 证 人
Surveyor</td><td colspan="2"></td></tr>
<tr><td rowspan="7">试验情况
Test information</td><td colspan="2">设备运行状态
Equipment running status</td><td colspan="2"></td></tr>
<tr><td colspan="2">控制和监控系统的功能发挥
Functioning of control and monitoring system</td><td colspan="2"></td></tr>
<tr><td rowspan="5">系统参数
Engineering parameters</td><td colspan="2">流量 Flow rate</td><td></td></tr>
<tr><td colspan="2">剂量 UV Dose</td><td></td></tr>
<tr><td colspan="2">进口压力outlet pressure</td><td></td></tr>
<tr><td colspan="2">出口压力inlet pressure</td><td></td></tr>
<tr><td colspan="2">反应单元温度：Tem. in the reaction unit</td><td></td></tr>
<tr><td colspan="2">电源柜内温度：Tem. in the power cabinet:</td><td></td></tr>
</table>

Table 6.3 BWMS maintenance record sheet

No;

Maintenance date	
Scheduled maintenance	
Unscheduled maintenance	
malfunction description	
malfunction causes analysis	
repairs	
Repair result	
Result verification	

7 Test Schedule

The schedule for OceanDoctor BWMS shipboard test is as follows:

Table 7.1 shipboard test schedule

date	arrangement
March 2013	system installation and commissioning
April to October	Model HBS-250 OceanDoctor BWMS shipboard test
April to October	Model HBS-500 OceanDoctor BWMS shipboard test